MEASUREMENT OF PRECISION GEOMETRIC DISTANCES TO THREE ANCHOR POINTS IN THE LOCAL UNIVERSE

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Our program, funded by a NASA/SARA 3-yr grant, is designed to measure distances directly with accuracies of 5% to three anchor points in the Local Universe. We are attacking this problem on three fronts, using Very Long Baseline Interferometry (VLBI) observations of NGC 4258, M 33, and Sgr A*. We plan to provide distance estimates, with a minimum of systematic uncertainty, that can be used to re-calibrate several "standard candles," such as Cepheid and RR Lyrae variables. This will place the Galactic and extragalactic distance scales on much firmer ground. The program will provide crucial, independent checks and calibrations of extragalactic distance measurements, and will contribute to the ultimate success and impact of the HST Key Project on Extragalactic Distances, the Full-Sky Astrometric Mapping Explorer (FAME), and any future NASA astrometric missions. Additionally, since distances are fundamental to astrophysics, our results will affect a large number of general projects on NASA facilities such as the HST, CXO, and NGST.

In the second year under our grant, we have made progress for each source:

1) NGC 4258: We have calibrated and imaged data from more than half of our VLBA observations, comprising bi-monthly observations over a period of over 1.5 years. We have overcome some software problems in the NRAO VLBA correlator/AIPS analysis path that limited positional accuracy. We are now in the process of modeling the accretion disk, using all of the available data, with the primary goal of reducing model-dependent uncertainties in the distance estimate.

2) M 33: We concluded our three epoch VLBA observations this year for this galaxy. These observations are designed to directly determine the angular rotation rate of the galaxy by measuring the relative positions of two H2O masers in different star forming regions on opposite sides of the galaxy. We are in the middle of the data analysis, having mapped the source at two of the three epochs, and if the data from the third epoch is as good as from the first two epochs, we expect to have an excellent result. This would be the first high-accuracy measurement of the angular rotation of a galaxy and, comparison with the galaxy's known rotation speed, should yield a direct measurement of its distance.

3) Sgr A*: We are still working toward the goal of obtaining a trigonometric parallax measurement for the compact radio source at the center of the Milky Way (Sgr A*). Currently we have achieved relative positional accuracy of 100 micro-arcseconds for this difficult target. The very low source declination and large (scattered) angular size of the source make it considerably harder to determine accurate positions compared, say, to M 33. We have proposed VLBA observations for March 2003 in which we will attempt a new calibration technique, that may help remove some of our largest source of systematic error: the large-scale atmospheric propagation delay at each antenna in the VLBA.

In summary, we are making good progress toward our very ambitious goals of high accuracy, direct distance measurements to two galaxies and the Galactic Center.